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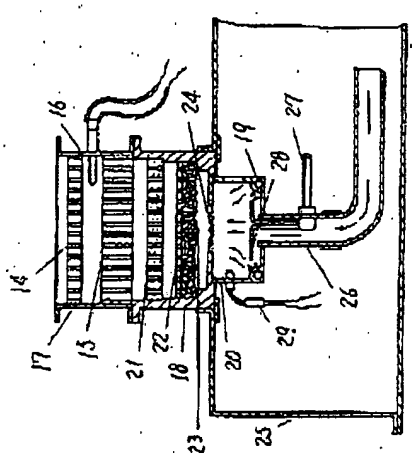
(54) CATALYTIC COMBUSTION APPARATUS

(57) Abstract:

PURPOSE: To keep stabilized combustion in a catalytic combustion apparatus, by providing a honeycomb heat insulating plate, a honeycomb catalyst body, and a back fire preventive plate in the combustion apparatus from the downstream side to the upstream side in order, and by providing a diffusion plate made of expanded ceramics between a vaporizing cylinder and a back fire preventive plate.

CONSTITUTION: A combustion cylinder 17 made of heat-resistant metal is composed of a honeycomb heat insulating plate 14 and a honeycomb catalyst body 15, and an ignition heater 16 is provided between them. A mixing cylinder 18 made of metal of high thermal conductivity, Al, for example, is fitted to the bottom of a combustion cylinder 17, and a vaporizing cylinder 20, having built-in sheath heater 19 in it, is fitted to the bottom of a mixing cylinder 18. A diffusion plate 23 made of expanded ceramics is provided in the mixing cylinder 18 underneath a back fire preventive plate 21, consisting of porous plate made of ceramics, and a punched injection plate 22. A resistance 24 consisting of wire net is provided to the opening to connect the mixing cylinder 18 with the vaporizing cylinder 20. With such an arrangement, comparatively compact combustion chamber can be composed, in which stabilized combustion can be taken place, if the rate of combustion and the rate of air are largely changed.



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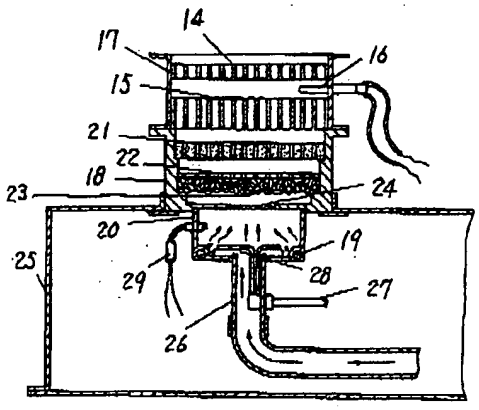
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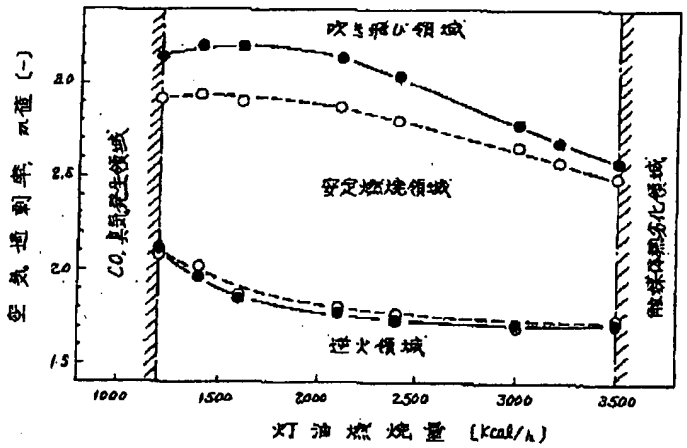
吹き飛び領域
安定燃焼領域
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2.0
2.5
2.0
1.5
1000
1500
2000
2500
3000
3500
灯油燃焼量 (kcal/h)

Laid-open Publication No. S60-53711 (A)
Laid-open Publication Date: March 27, 1985
Title of the Invention: A catalyst combustor
Patent Application No. S58-163507
Filing Date: September 5, 1983
Inventor: Y. Shimada, I. Matsumoto
Applicant: Matsushita Electric Industrial Co., Ltd
Agent: T. Nakao, Attorney

S60-53711A

SPECIFICATION

1. TITLE OF THE INVENTION

A catalyst combustor

2. WHAT IS CLAIMED IS:

1. A catalyst combustor comprising:

a honeycomb heart-retention plate made of heat-resistant ceramics;

a honeycomb catalytic medium; and

a back fire preventive plate, which are disposed in the above sequence as defined from downstream side toward upstream side along a flow of premixed fuel-air mixture, said catalyst combustor characterized in further comprising a diffusion plate of foamed ceramics, which is disposed between a vaporization cylinder defined in the upstream side and said back fire preventive plate.

2. A catalyst combustor in accordance with claim 1, in which said honeycomb catalytic medium comprises a honeycomb carrier and at least one type of oxide of transition metal selected from a group consisting of Fe, Ni, Co and Cr, carried on said honeycomb carrier.

3. A catalyst combustor in accordance with claim 2, in which heat-resistant ceramics, such as alumina, mullite, mullite-zircon and zirconia, are employed as a material for said carrier.

4. A catalyst combustor in accordance with claim 1, in which cordierite is employed as a material for said diffusion plate of foamed ceramics.

3. DETAILED DESCRIPTION OF THE INVENTION

Field of the invention

The present invention relates to a catalyst combustor, in which a variety type of gaseous fuel or a vaporized liquid fuel is supplied along with a combustion air over a catalytic medium so as to induce an oxidation reaction on a surface thereof to thereby generate heat, which will be in turn utilized.

Configuration of prior art example and problems associated therewith

A catalyst combustor according to the prior art comprises typically, as shown in Fig. 1, a cylindrical catalytic medium 2 in a honeycomb configuration and a back fire preventive plate

3 in a disc-like configuration having a number of small blowout holes formed therethrough, which are disposed within a cylindrical combustion cylinder 1, and further includes a punching metal 5 and a porous plate of ceramics 6, which are both disposed between a vaporization cylinder 4 and the back fire preventive plate 3. Besides, as for a means for supplying a fuel, the prior art catalyst combustor has employed a pulsed supply method by an electromagnetic pump, though not shown. If this method is used to carry out the catalytic combustion, due to its nature pertaining to the pulsed fuel supply, pulses from the electromagnetic pump generates pulsations, which would result in uneven mixing of the fuel with the air, and so it had been difficult to carry out a uniform catalytic combustion across the catalytic medium 2. Especially, in case of the combustion with a low combustion volume, in which the pulse interval of the electromagnetic pump is inevitably longer, the above-mentioned trend could be observed significant, failing to carry out a stable combustion. Another example according to the prior art using no honeycomb configuration of the catalytic medium comprises, as shown in Fig. 2, a catalyst layer 9 filled up with particles of catalytic medium in the form of pellet 8, a pair of porous plates 10 for holding the catalyst layer 9 therebetween, and a back fire preventive plate 11 similar to that shown in Fig. 1, which are entirely disposed within a combustion cylinder 7, but this example has employed, instead of the porous plate of ceramics 6 as shown in Fig. 1, a diffusion layer 13 filled up with ceramic rings

12, which is held by said pair of porous plates 10 also used to hold the catalyst layer 9. In this method, although a mixing and diffusion of the fuel and the air can be maintained to be uniform by said diffusion layer 13 and the catalyst layer 9, it requires the significant length for both of the diffusion layer 13 and the catalyst layer 9, leading to a problematic situation of a bulky profile of the entire combustor.

Object of the present invention

The present invention is made to solve the above problems associated with the prior art, and an object thereof is to provide a catalyst combustor having a relatively compact profile of a combustion chamber and enabling a stable combustion condition to be maintained even with a widely varying combustion volume and air volume.

Configuration of the invention

To accomplish the above object, the present invention employs a basic configuration of a catalytic combustor, comprising a honeycomb heart-retention plate, a honeycomb catalytic medium, and a back fire preventive plate, which are disposed in the above sequence as defined from downstream side toward upstream side along a flow of premixed fuel-air mixture, and further including a diffusion plate of foamed ceramics interposed between a vaporization cylinder and said back fire preventive plate. In this configuration, if the pulsed supply method by an electromagnetic pump is employed as the fuel supply method, the pulsations during the supply of the fuel can be absorbed while passing through the fine perforations in the form of labyrinth extending vertically

and horizontally in said diffusion plate of foamed ceramics, and as a result, a stable premixed fuel-air mixture can be supplied onto the catalytic medium, so that the stable combustion condition across the catalytic medium and thus the clean emission gas are ensured.

Description of the embodiments

The present invention will now be described with reference to an embodiment shown in Fig. 3, which has been given by way of illustration only.

A combustion cylinder 17 made of heat resistant metal and comprising a honeycomb heat-retention plate 14, a honeycomb catalytic medium 15, and an ignition heater 16 interposed between said two elements is in its rear portion coupled with a mixing cylinder 18 made of metal of high heat conductivity, such as Al, for example, which is in turn in its rear portion coupled with a vaporization cylinder 20 embedded with a sheathed heater 19. Within the mixing cylinder 18 are disposed a back fire preventive plate 21 made of ceramic porous plate, and a diffusion plate of foamed ceramics 23 according to the present invention with a punching blowout plate 22 placed thereon, and further a resistor element 24 made of wire-net is disposed in a joint port between the mixing cylinder 18 and the vaporization cylinder 20. Further, a bottom portion of the mixing cylinder 18 is securely supported by an outer casing 25. The vaporization cylinder 20 in its bottom portion is fitted with a blow-in pipe 26, and through a wall of said blow-in pipe 26 an oil feed pipe 27 is horizontally introduced. A part of the feed pipe 27

defined in the inside of the blow-in pipe 26 is coupled with two fuel injection pipe 28, whose injection ports are facing oppositely to each other and configured to inject the fuel to impinge upon regions of high temperature in the vaporization cylinder 20. Furthermore, a thermo-couple 29 acting to control a vaporization temperature is arranged laterally through and into the vaporization cylinder 20.

An operation of the embodiment according to the above configuration will now be described.

After the sheathed heater has been turned on and when the thermo-couple 19 detects that the temperature in the sidewall of the vaporization cylinder 20 has reached a predetermined temperature, then a fun and an electromagnetic pump (either of them not shown) are turned on to thereby initiate the supply of air and liquid fuel. Since the liquid fuel is introduced into the vaporization cylinder 20 through the extremely fine fuel injection pipe 28 from the feed pipe 27, the liquid fuel from the tip of the fuel injection pipe 28 will impinge upon the sidewall of the vaporization cylinder 20 with a considerable velocity, and so it will evaporate while developing fine grains. On the other hand, the air that has been introduced into the vaporization cylinder from the blow-in pipe 26 may be mixed with said vaporized fuel to some degree, but when it passes through the resistor plate 24 in the exit of the vaporization cylinder 20, they might turn out to be in quite uneven condition of the premixed fuel-air mixture. When such fuel-air mixture in the above condition reaches the diffusion plate of foamed ceramics 23, since said

fuel-air mixture in the unevenly mixed condition causes turbulent diffusion owing to the fine perforations in the labyrinth of the diffusion plate of foamed ceramics 23, it turns into the uniformly mixed condition at the time of its passing through the punching blowout plate 22. When the fuel-air mixture in this condition has passed through the honeycomb catalytic medium 15, it is ignited by the ignition heater 16 holding a high red heat in a range of 900 to 1000℃ through power supply. Just after the starting of ignition, filmy flame is developed immediately above the honeycomb catalytic medium 15, and the heat generated from this flame gradually effects to the interior of the honeycomb catalytic medium 15 to allow the entire honeycomb catalytic medium 15 to reach an activating temperature, thereby accomplishing the stable condition of the catalytic combustion. Further, since the honeycomb heat-retention plate 14 is arranged above the honeycomb catalytic medium 15, the cooling effect from the external air can be suppressed, thus ensuring the further stabilized condition of the catalytic combustion to be obtained. Furthermore, the pulsations generated by the electromagnetic pump during the fuel supply can be absorbed by the fine perforations of the diffusion plate of foamed ceramics 23, and so it would be no more effective to the combustion across the honeycomb catalytic medium 15.

Fig. 4 shows a graphical representation of the effect of the catalyst combustor according to the present invention in comparison with the example according to the prior art as shown in Fig. 1. Considering of the fact that the combustion

performance of the honeycomb catalytic medium depends on an area and a diameter of an opening of the catalytic medium, the one and the same honeycomb catalytic medium (size defined by ϕ130 x ℓ 20) was used for both the embodiment of the present invention and the prior art example. The material thereof employed the one containing a primary component of ZrO_2. In Fig. 4, the vertical axis is indicative of the excess air ratio (by m value), while the horizontal axis is indicative of the combustion volume of a kerosene, wherein the curves defined by the black dots represent the embodiment of the present invention, while the curves defined by the white dots represent the prior art example. It is to be noted that the each of the upper curves defines a blow-off limit indicative of such a limit where when the excess air ratio is increased, the balance in combustion over the catalytic medium 2 or the honeycomb catalytic medium 15 would be broken, and resultantly the flame could be locally blown off or CO could be produced, ultimately no more stable combustion being obtainable, while each of the lower curves defines a back fire limit indicative of such a limit where when the excess air ratio is reduced to make it approaching to the theoretical combustion air volume, the flame would be produced behind the back fire preventive plate 3 or the back fire preventive plate 21, and resultantly the catalytic combustion without flames could be no more obtainable over the catalytic medium 2 or the honeycomb catalytic medium 15, with a range defined between the blow-off limit and the back fire limit considered as the stable combustion range. It is observed in Fig. 4 that

the blow-off limit values for the prior art example are shifted toward the lower m value side as compared to the embodiment of the present invention, indicating that the combustion balance is more likely broken than the embodiment of the present invention. It is thus understood that the embodiment of the present invention enables the stable combustion even with a high air-fuel ratio, as compared to the prior art example.

Effect of the invention

According to a catalyst combustor of the present invention, the below-listed effect could be obtained.

(1) Owing to a configuration, in which a honeycomb heat-retention plate, a honeycomb catalytic medium, and a back fire preventive plate are disposed in this sequence as defined from downstream side along a fuel-air mixture flow, and a diffusion plate of foamed ceramics is interposed between a vaporization cylinder located in the most upstream side and said back fire preventive plate, a mixture of fuel gas and air can be held in a uniformly mixed condition to be supplied over said honeycomb catalytic medium.

(2) Owing to the above configuration, the stable combustion can be provided even in a higher excess air ratio.

(3) Owing to the above configuration, which eliminates the need for a diffusion plate made of multiple steps of punching metal or wire net aiming for the uniform mixing of the fuel gas with the air, a mixer is allowed to be of relatively compact profile, thus allowing a combustor in itself to be made compact.

4. DESCRIPTION OF THE DRAWINGS

Fig. 1 is a longitudinal section view of a catalyst combustor according to the prior art;

Fig. 2a is a longitudinal section view of another catalyst combustor according to the prior art, and Fig. 2b is a perspective view of a ceramic ring;

Fig. 3 is a longitudinal section view of one embodiment of a catalyst combustor according to the present invention; and

Fig. 4 is a graph for illustrating combustion characteristics in the comparison between the prior art example as shown in Fig. 1 and the embodiment of the present invention,

wherein, reference numeral 14 designates a honeycomb heat-retention plate, 15 a honeycombs catalytic medium, 20 a vaporization cylinder, 21 a back fire preventive plate, and 23 a diffusion plate of foamed ceramics.

TRANSLATION OF THE WORDS IN THE DRAWINGS

[Fig. 4]

空気過剰率 m値：Excess air ratio, m value

灯油燃焼量：Kerosene combustion volume

ＣＯ．臭気発生領域：CO odor generated region

触媒体流劣化領域： Catalytic medium heat-deterioration region

吹き飛び領域： Blow-off region

逆火領域： Back fire region